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United States Department Of Agriculture
Forest Service
Lassen National Forest
55 South Sacramento St.
Susanville, CA 96130

Reply To: 3420 Date: June 30, 1994

Subject: Evaluation of White Fir Mortality on Big Valley RD (FPM Rept. NE94-2)

To: Forest Supervisor, Modoc NF

The Big Valley RD, Modoc NF, has been experiencing high levels of white fir mortality over the past several years. Some of the ridges on the District which lie generally to the north of the town of Adin have had as much as 80 percent of the stems killed. Some of the mortality has already lost all commercial value due to the rapid deterioration of small diameter white fir. Part of the urgency of salvage is to reduce the enormous amount of fuel while it is still economical to do so. Salvage efforts have been delayed due to the need for consultation with the US Fish and Wildlife Service. Several streams in the area are habitat for the Modoc sucker, Catostomus microps, which is listed as an endangered species by both the Federal Government and the State of California. The objective of evaluating the stands was to get a short-term and long-term prognosis of white fir mortality on the District.

The following people examined trees on the Big Valley RD on May 16, 1994:

Dave Schultz	Entomologist	Forest Pest Management
Bill Woodruff	Pathologist	Forest Pest Management
Chris Click	Silviculturist	Big Valley RD
Bill Merrihew	Silviculturist	Modoc NF

Portions of several sales were examined (see map for approximate locations). In all cases, white fir was the predominant tree species which was dying. The immediate cause of mortality in most cases was attacks by the fir engraver, Scolytus ventralis, with its associated brownstaining fungus, Trichosporium symbioticum. Other insects which are contributing to the mortality include two smaller engraver beetles, Scolytus subscaber, and Scolytus praeceps, as well as the roundheaded fir borer, Tetropium abietis. The underlying cause of the mortality was a series of years with below-normal precipitation. Table 1 shows the precipitation record for some selected recording stations in the general area.

TABLE 1 *

Location	Normal (inches)	Precipitation 1987	1988	1989	1990	1991	1992
Adin RS	16.06	11.36	9.53	12.98	13.68	15.83	10.05
Alturas RS	12.45	9.46	11.83	10.05	8.73	13.35	8.72
Cedarville	14.39	8.81	12.52	10.35	9.11	14.00	10.61
Hat Cr. PH 1	18.39	15.55	13.89	M	11.87	17.18	12.31

* Data extracted from U.S. Dept. of Commerce, NOAA, Annual Reports.

Precipitation for 1993 was generally above normal. Precipitation for 1994 to date has been below normal.

White fir mortality commonly increases in response to drought. The mortality is usually caused by both successful and unsuccessful attacks by the fir engraver. Unsuccessful attacks are those in which the adult beetles have begun to bore into the tree, but where the tree is still vigorous enough to flood the adult gallery with resin. Large amounts of resin either cause the adults to stop boring before eggs are laid, or may actually kill newly hatched larvae. In spite of being unsuccessful from the standpoint of fir engraver reproduction, a large number of unsuccessful attacks may cause the death of a tree by disruption of the phloem by adult galleries and the introduction of brownstaining fungi. Trees which receive only a small number of unsuccessful attacks may grow over the aborted adult gallery to form a pitch pocket in the wood.

On the Modoc NF, the fir engraver will have one generation per year. Trees are attacked only during the hottest part of the year. On the Big Valley RD, fir engraver attacks could take place from late June through early September. White fir which are attacked by the fir engraver will usually not begin to fade until the spring of the following year.

As a result of the long life cycle of the fir engraver and the short growing season of the host tree, the level of fir mortality does not change rapidly. The white fir which faded during the spring of 1994 were attacked during the summer of 1993 in response to low precipitation during the winters of several previous years. Because there is currently a high population of fir engraver beetles on the District, and also a large number of stressed white firs, there should be a lot of fir trees which are attacked this summer and fade during the spring of 1995.

The pattern seen in California following the 1975-77 drought was that it took several winters with adequate precipitation before the level of fir mortality dropped to normal. Even if precipitation returned to normal during the next several winters, a large number of white firs would be expected to fade on the Modoc NF during the springs of 1996 and 1997.

White fir mortality is not distributed evenly across the Modoc NF. The distribution of both white fir, and white fir mortality are strongly influenced by the mean annual precipitation. The lower limit of precipitation in the natural range of white fir is about 20 inches (Fowells, H.A. 1965. Silvics of Forest Trees of the United States. Ag. Handbook No. 271. USDA-FS. 762p.). The mapped distribution limits of white fir for the area of the Modoc NF tend to coincide with areas which receive 20 or more inches of precipitation annually (Griffin, J.R. and Critchfield, W.B. 1972. The Distribution of Forest Trees in California. USDA-FS Res. Paper PSW-82. 114 p.).

An isohyetal map of mean annual precipitation can be used to rate the risk of high white fir mortality on the Modoc NF. The attached overlay can be used to superimpose the risk of high white fir mortality on both of the attached location maps (source: Rantz, S.E., 1969. Mean Annual Precipitation in the California Region. U.S. Geological Survey. Menlo Park, CA). The overlay is coded as follows:

(Blue) Low Risk. 40+ inches annual precipitation. These areas easily support stands of white fir and red fir. Stands of lodgepole pine are also common. Common associates include ponderosa pine and sugar pine. Western white pine and mountain hemlock may be found at the higher elevations. Mortality will be low, even during drought periods. Thinning will increase the rate of tree growth, but will show only slight differences in tree mortality.

(Green) Medium Risk. 30-40 inches annual precipitation. Stands in these areas often have a high percentage of white fir. White fir may achieve a considerable age and size in these areas. Ponderosa pine is often dispersed throughout the stand at a wide spacing. There may be scattered individuals of incense-cedar or sugar pine. Prolonged drought may cause mortality of 5-10 percent of the stems. Periodic thinning which concentrates on removing white fir ingrowth will lower mortality by maintaining a more sustainable amount of biomass, as well as promoting a more stable mixed-species stand.

(Yellow) High Risk. 25-30 inches annual precipitation. In the absence of fire, these areas have stands which are dominated by densely stocked, small diameter white fir. Scars on stumps and the oldest trees in these stands indicate that ground fires were relatively common in the past. The species distribution by age class shows an increase in the relative percentage of white fir in the stands following fire suppression. In addition to white fir, these areas generally contain several of the species indicative of mixed conifer stands. Ponderosa pine or Jeffrey pine, incense-cedar, and sugar pine or western white pine tend to be relatively common in these areas. California black oak and Douglas-fir are present in a few areas. Prolonged drought may cause mortality in excess of 50 percent of the stems. In some cases the mortality includes trees of all species which appeared relatively thrifty at the time of death. The risk of mortality can be

lowered by thinning to a wide spacing prior to the onset of drought, and by promoting a mix of tree species which are native to that area.

(Red) Extreme Risk. 20-25 inches annual precipitation. These areas are generally ponderosa pine, or Jeffrey pine stands. Common ground cover plants and shrubs include Wyethia mollis, rabbitbrush, sagebrush, and antelope bitterbrush. Juniper and mountain mahogany may be present. White fir, and in some cases incense-cedar, have seeded into the understory of the pine stand. In some cases, the shade tolerant trees may live long enough to achieve an intermediate or co-dominant crown position. Prolonged drought may cause mortality of 80-85 percent of the stems. In stands where the total stocking of both overstory and understory is high, mortality may also occur in the pines. In these types of areas where white fir trees were left to "fill a hole" in thinned pine stands, a high percentage of the former understory white fir trees were killed following prolonged drought. The risk of mortality may be lowered by managing groups of pines as single story aggregations at wide spacing. Prescribed burning may be useful to maintain open stand conditions, if it is compatible with other resource objectives.

(Uncolored within Modoc NF boundaries) Not included in range of white fir. Less than 20 inches annual precipitation. This includes some pine stands, some juniper woodland, and some non-forested areas. White fir will occasionally be found in this area. White fir begins to produce seed as early as 40 years of age and the maximum number of seeds produced on a single white fir tree in a given year is estimated to be about 190,000. These characteristics allow white fir to regularly seed into areas where conditions are not suitable for long-term survival. As a generality, it is not biologically realistic to manage white fir as a resource in these areas.

By using the White Fir Mortality Risk overlay and the Sales Location maps, some generalizations about the sales can be made:

Sale	**Risk of White Fir Mortality**
Donica (Units in T. 40 & 41N, R. 7 E.)	Not in Range of White Fir
Dutch	Not in Range of White Fir
Shake Canyon	Not in Range of White Fir
Johnson Creek	Borderline between Not in Range of White Fir and Extreme Risk
Donica (Units in T. 42 N., R. 7 E.)	Extreme Risk
Stone Coal	Extreme Risk
Rucker	Extreme Risk
Higgins CM	Extreme Risk

The Mortality Risk map represents broad averages of conditions over large areas. Within each risk zone there are probably some microsites which are very different from the broad average. In both the area classified as Extreme Risk of White Fir Mortality, as well as area identified as Not Included in Range of White Fir, it is possible to find an isolated, individual white fir which has obviously survived to an advanced age. White fir growing in these areas which appear to be more than about 100 years old, or are larger than about 18 inches dbh are probably occupying a very favorable microsite. It may be very difficult to replace these trees because each tree probably represents the product of intense selection pressure on a large number of seeds which were shed into the area. If there is a desire to retain these isolated, older white fir to meet a management objective, it may be necessary to thin around these trees to reduce competition for available soil moisture and also to reduce the amount of fuel.

MANAGEMENT ALTERNATIVES

1. Do Nothing. White fir mortality is already high in the sales areas. White fir will continue to fade until at least 1997. White fir mortality in similar stands has tended to drop off after 80-85 percent of the stems were killed. The small diameter white fir should begin to fall by the third year after death. In similar white fir stands on the Shasta-Trinity NFs, approximately 82 percent of the sample points which had the overstory reduced by mortality to 80 square feet or less of basal area, already had 200 or more seedlings and saplings per acre. Approximately 80 percent of the regeneration in the areas of high white fir mortality consisted of white fir seedlings and saplings. In the absence of fire or management activity, the current scenario is likely to repeat itself in another 40 to 70 years. Large amounts of fuel will be present on the site for a number of years.

2. Salvage dead trees. Removal of the obviously dead white fir trees will not lower future mortality. The use of machinery in these stands has a slight potential to increase future mortality by causing wounding or disturbance to the leave trees. The major effects of salvage would be to remove some wood while it still has some commercial value, and also to reduce the amount of fuel in the treated stands.

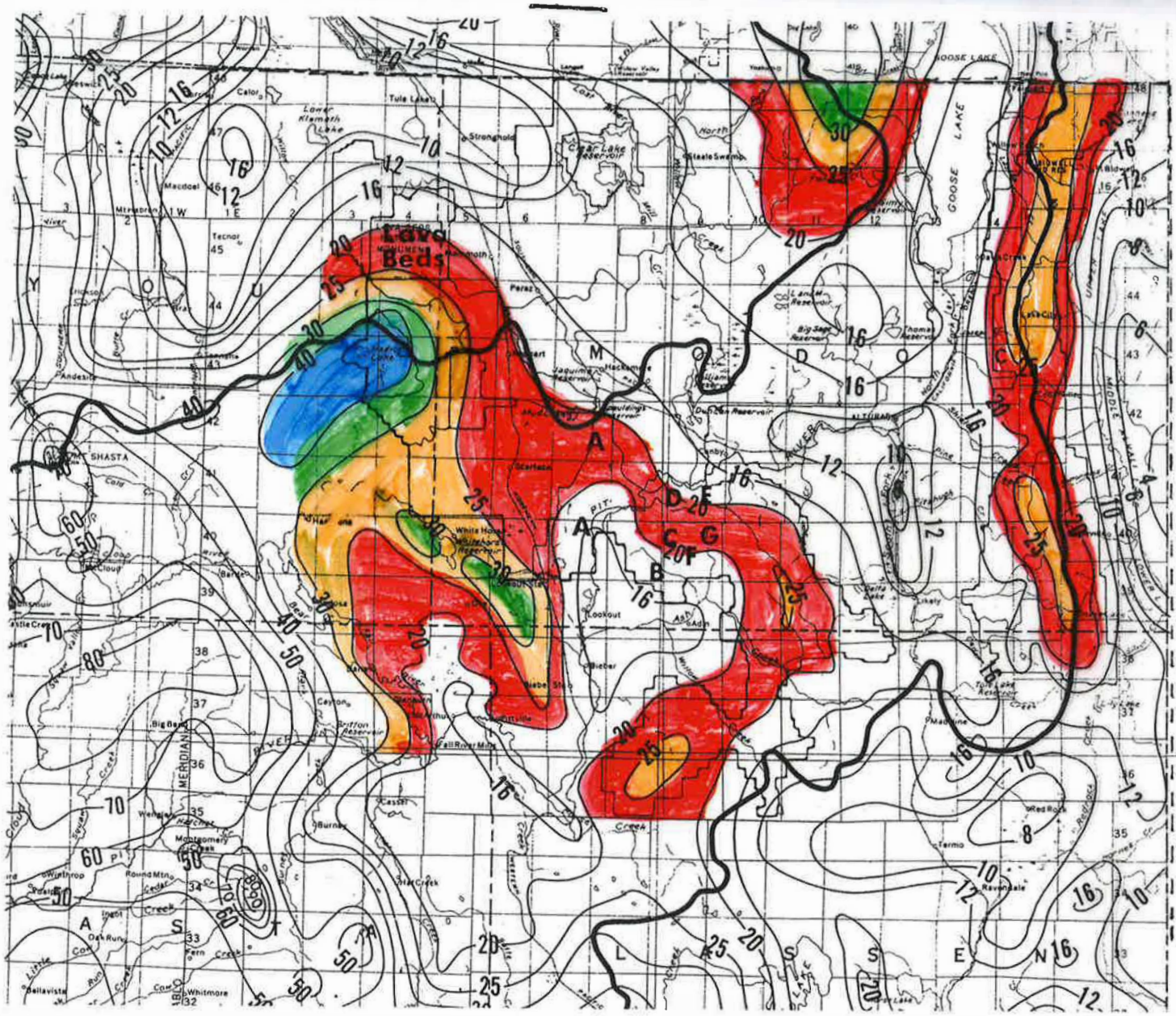
3. Salvage dead trees and harvest trees likely to die in near future. Given the location of the sales, it is likely that many additional white firs will die during the next three years. Inclusion of the white fir likely to die in the near future in a salvage sale with the dead trees would remove a maximum amount of fuel in a single operation. Increased economic efficiency of a single entry may increase the amount of money which can be collected for sale area improvements. The only white fir trees in the sales areas which have a low probability of mortality during the next few years are seedlings and saplings with a stem diameter less than approximately 3 inches because these trees are too small to become infested by the fir engraver. White fir trees with a pre-dominant crown position in the stand have a better than average probability of survival. Thinning around pre-dominant white firs should enhance their chance of survival. All other size classes and crown classes of white firs in

the sales areas have a high probability of mortality during the next few years. Although the wood deteriorates rapidly after death, some living white firs might be left to satisfy short-term (up to 5 year) snag needs.

4. Use mortality risk to formulate stand prescriptions. During this century, there have been prolonged droughts in the area during 1928-34, 1975-77, and 1987-92. If the future is similar to the past, mortality associated with prolonged droughts will kill most white fir before they achieve a large diameter. Unless these areas are being managed for habitat for a species which is dependent on small diameter dead white fir, or there is an economic market for small diameter white fir, then it would promote a more sustainable stand structure to manage for pine. Ground fires maintained the open condition of pine stands which were historically present in the sales areas. Depending upon the resource(s) being emphasized in an area, as well as the degree of control desired in selecting the vegetation to be retained and economic considerations, it may be possible to use various combinations of mechanical harvesting and prescribed burning to achieve the desired condition.

Please call Bill Woodruff at (916) 257-2151, or Dave Schultz at (916) 246-5087 if you need more information.

David E. Schultz
Entomologist
Forest Pest Management



BIG VALLEY RANGER DISTRICT

APPROXIMATE SALES LOCATIONS

A – DONICA

B – DUTCH

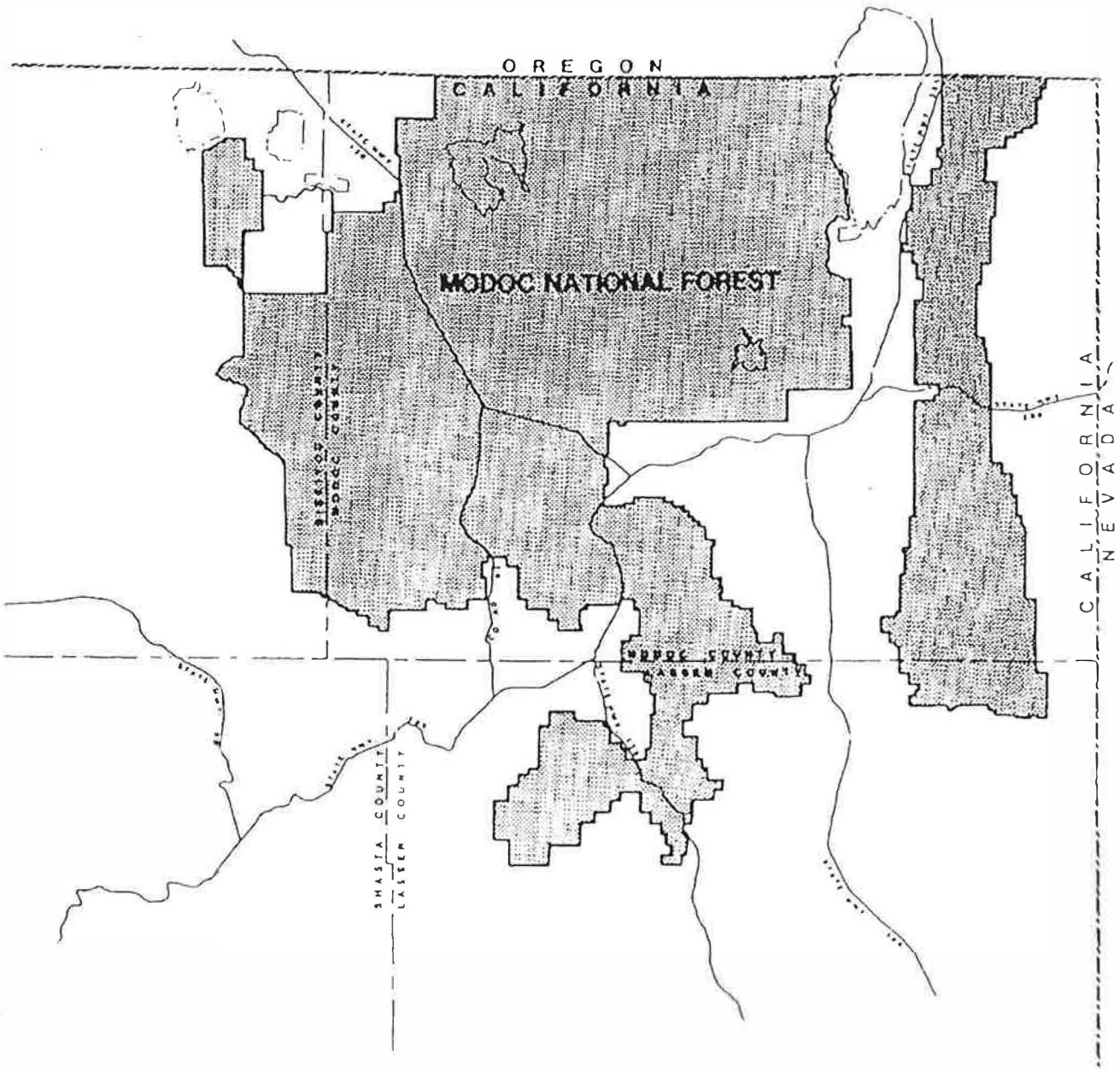
C – STONE COAL

D – RUCKER

E – SHAKE CANYON

F – JOHNSON CREEK

G – HIGGINS CM



LOCATION MAP